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(54) **WATERPROOF HOUSING FOR DIGITAL DEVICES HAVING CAPACITIVE TOUCH SCREEN AND ITS ACTUATOR MECHANISM**

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(51) **Int. Cl.**

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G06F 3/044	(2006.01)
G03B 17/08	(2006.01)
G06F 1/16	(2006.01)
H04M 1/18	(2006.01)
A45C 13/00	(2006.01)
A45C 11/00	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 3/044*** (2013.01); ***G03B 17/08*** (2013.01); ***G06F 1/1628*** (2013.01); ***H04M 1/18*** (2013.01); *A45C 13/008* (2013.01); *A45C 2011/002* (2013.01)

(58) **Field of Classification Search**

CPC G06F 3/041; G06F 1/16

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,352,961	B2 †	4/2008	Watanabe	
2007/0086273	A1 *	4/2007	Polany et al.	367/131
2009/0317069	A1 †	12/2009	Yim	
2013/0082963	A1 *	4/2013	Chu	345/173
2013/0161163	A1 *	6/2013	Nakamura et al.	200/16 R

FOREIGN PATENT DOCUMENTS

CN	101359156 A	2/2009
WO	2011022759	3/2011

OTHER PUBLICATIONS

International Search Report issued for PCT Application No. PCT/CN2012/082352 by the International Search Authority.

* cited by examiner
† cited by third party

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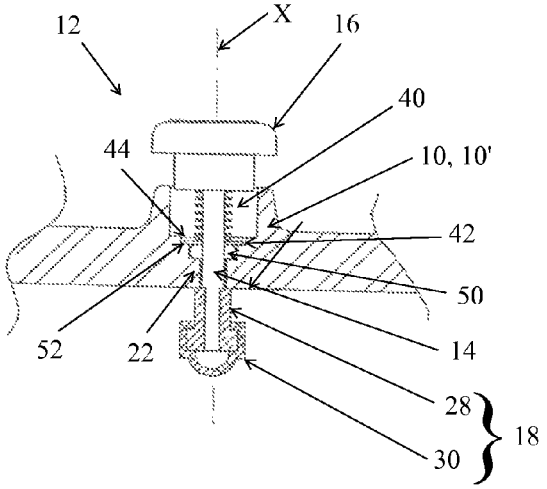
(57) **ABSTRACT**

An actuator mechanism for actuating a capacitive touch screen of a digital device held in a waterproof housing includes an actuator shaft extending through an opening formed on the housing, a press button connected to an outer end of the shaft, a probe head connected to an inner end of the shaft, and a biasing member adapted to urge the probe head away from the touch screen, whereby pushing the press button against the biasing force moves the probe head towards and in contact with the touch screen. A waterproof housing having actuator mechanisms is also disclosed.

20 Claims, 9 Drawing Sheets



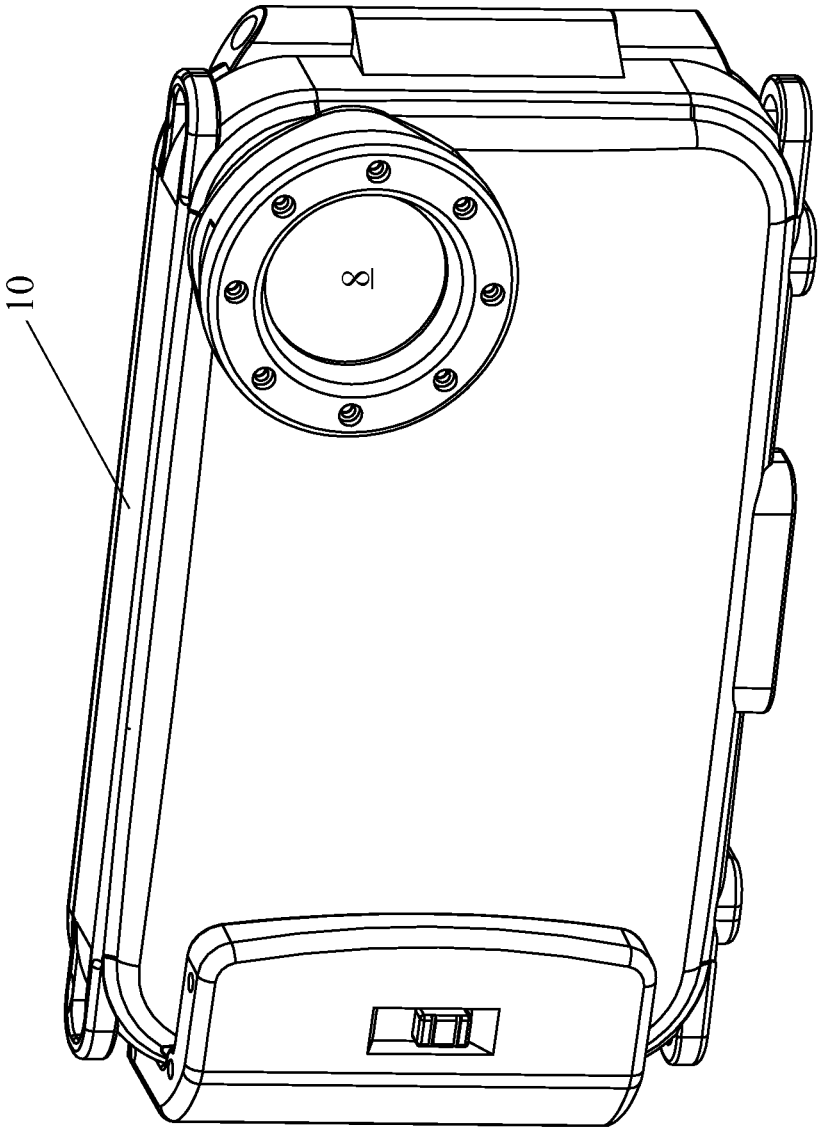


FIG. 1

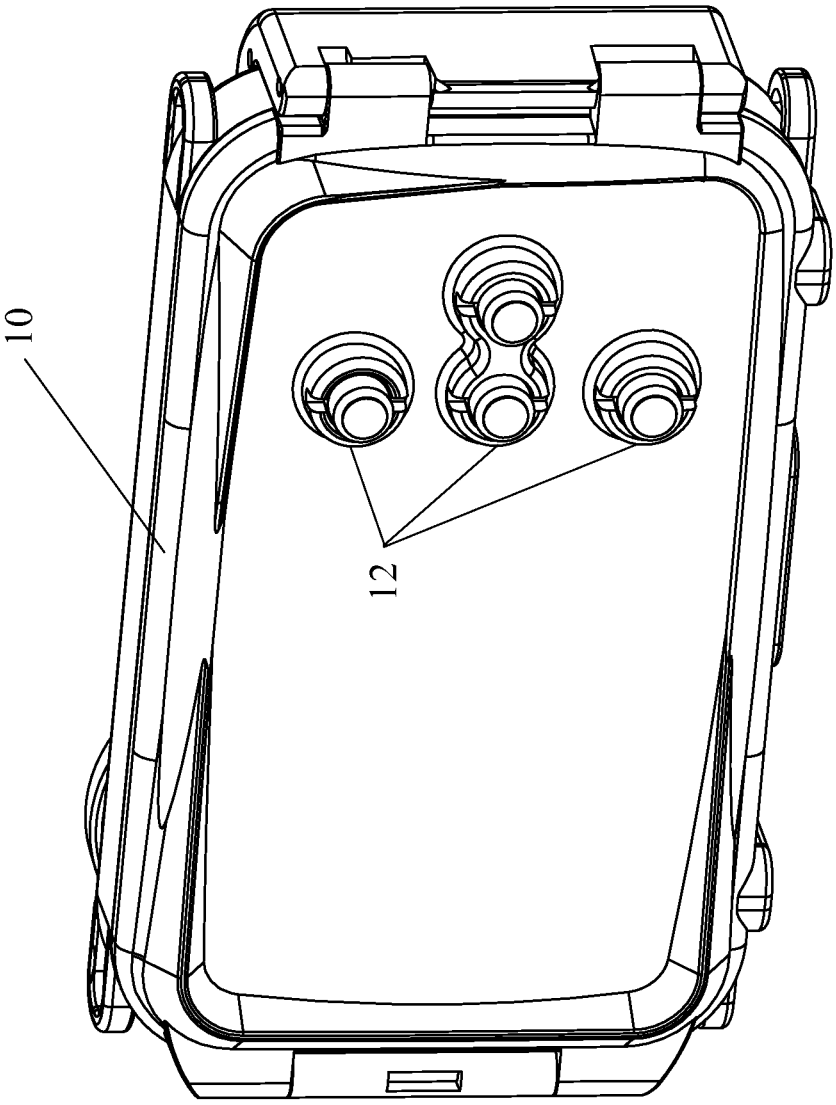


FIG. 2

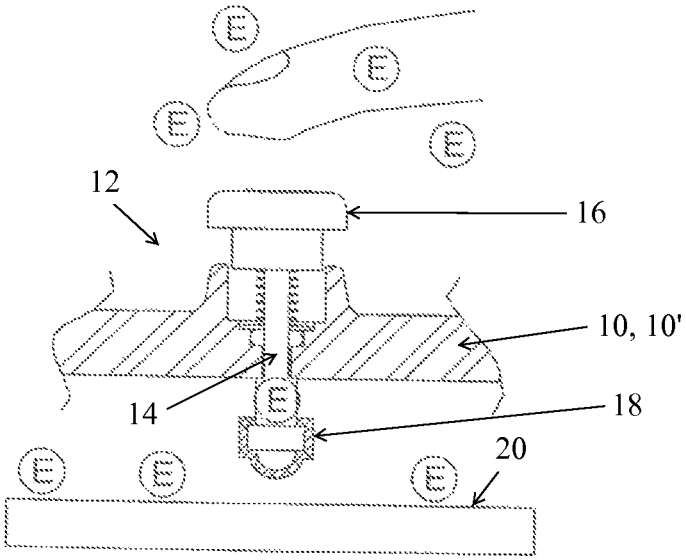


FIG. 3

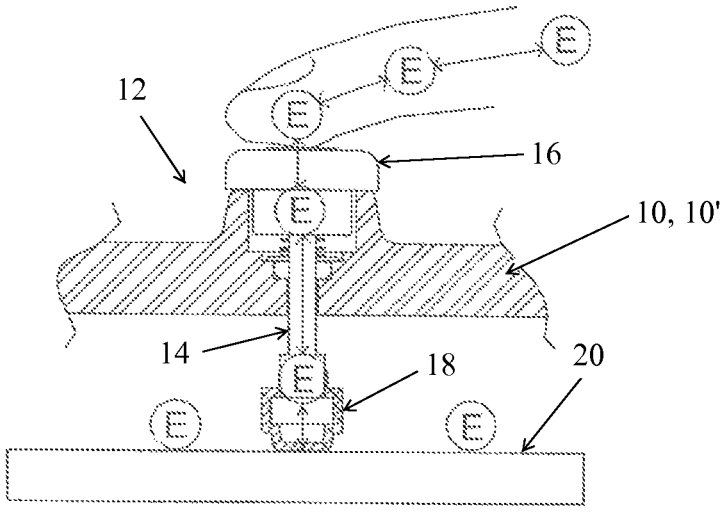


FIG. 4

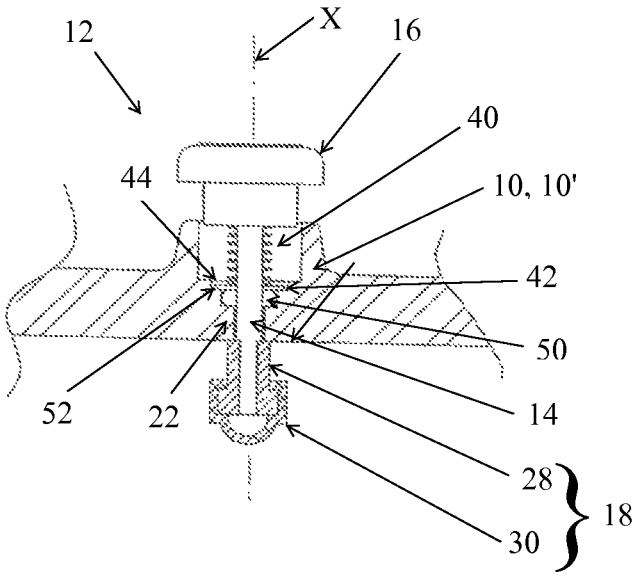


FIG. 5

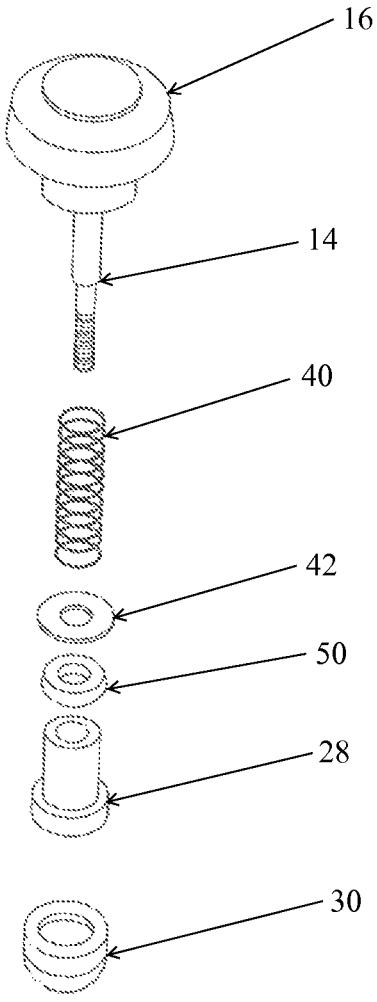


FIG. 6

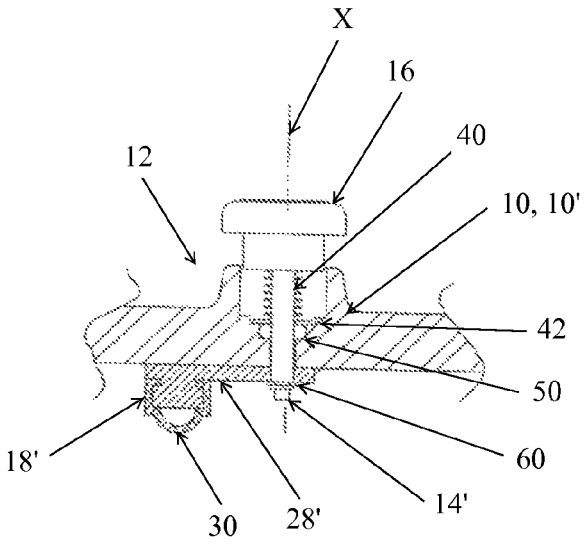


FIG. 7a

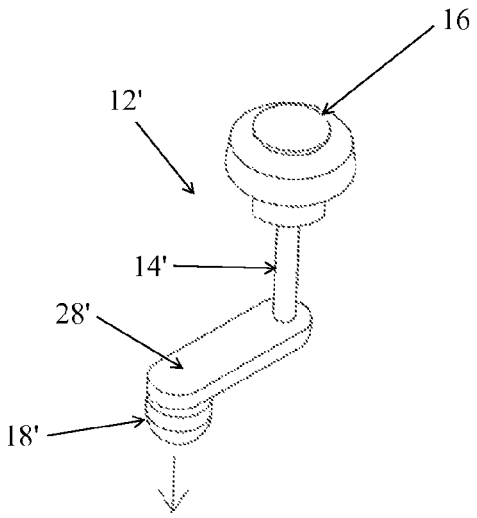


FIG. 7b

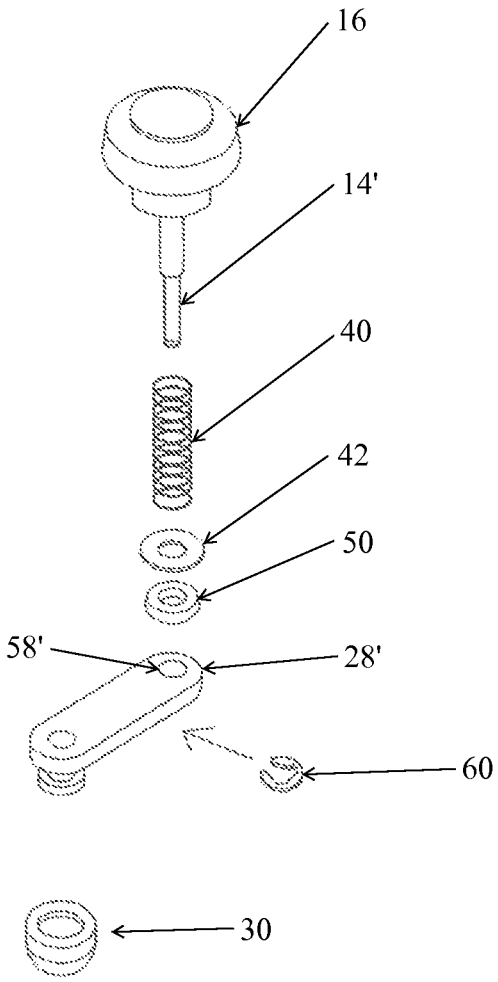


FIG. 8

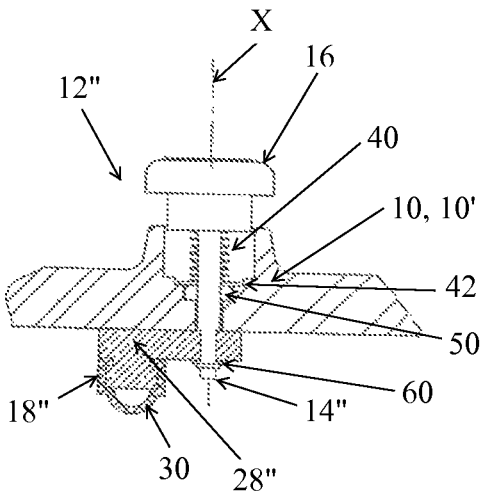


FIG. 9a

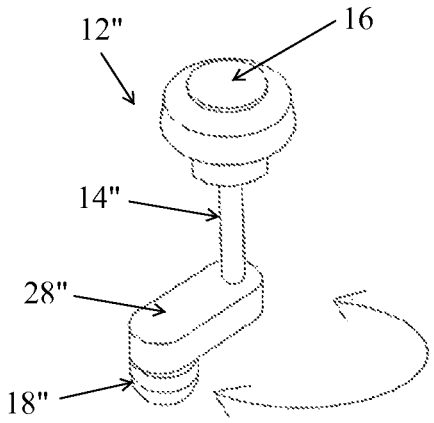


FIG. 9b

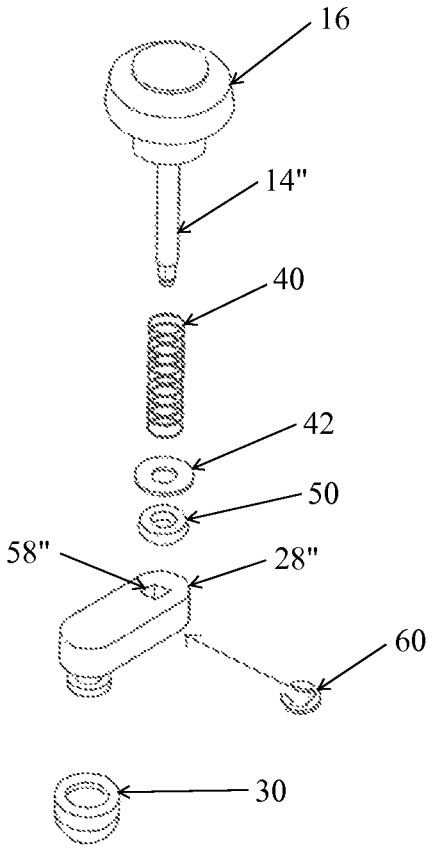


FIG. 10

WATERPROOF HOUSING FOR DIGITAL DEVICES HAVING CAPACITIVE TOUCH SCREEN AND ITS ACTUATOR MECHANISM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority of U.S. provisional patent application No. 61/542,290 filed on Oct. 3, 2011, the entire content of which is hereby incorporated by reference.

FIELD OF THE PATENT APPLICATION

The present patent application relates to a waterproof housing for digital devices, such as smart phones (e.g., iPhone), tablet computers (e.g., iPad) and digital cameras, having a capacitive touch screen. The present patent application also relates to an actuator mechanism for actuating a capacitive touch screen of a digital device held in a waterproof housing.

BACKGROUND

Many hand held digital devices, such as smart phones (e.g., iPhone), tablet computers (e.g., iPad) and digital cameras, are operated by touch screen input devices. A touch screen is normally a display screen which can identify the occurrence and position of a touch within a display region. The word "touch" usually refers to touch by a finger or body part of a user. It interacts with what is displayed on the screen rather than other input device, such as a keyboard, a mouse or a touch pad which interacts in an indirect way. There are many different types of touch screen available today. The most common types being used by hand held devices, such as smart phones, tablet computers and digital cameras are resistive and capacitive touch screens.

A resistive touch screen includes a glass sheet coated with a thin conductive layer and a metallic layer. The two layers are separated by a spacer. When a user makes contact with the touch screen, the two layers touch each other at the same location. The change in electric current will be identified and computed to a set of coordinates on the touch screen display. A resistive touch screen can be operated by fingers or by many types of object as long as it can provide pin point compression on the touch screen.

Another type of touch screen is capacitive touch screen. A capacitive touch screen includes a thin conductive layer such as Indium Tin Oxide, which is visually transparent. It stores electric charge and is positioned on a glass layer of the display. When a user makes contact with the touch screen, usually with a bare finger, small quantity of electric charge is transmitted to or from the user's finger. The quantity of electric charge on the touch screen at the designated position is reduced or increased. This change in electric charge is detected and computed to a set of coordinates on the display. A finger usually works well with capacitive touch screen. A human body is a good transferor and transferee of electric charge because of the electromagnetic field around the human body at all times. A device composed of compatible materials with good conductivity of electric charge can perform the function. However, a pencil or stylus which is workable on a resistive touch screen is not workable on a capacitive touch screen.

As previously mentioned, these touch screens can be used in many hand held digital devices. These digital devices may not be waterproof, and therefore cannot be used in wet or underwater environment. If a user wants to operate those devices in such environment, a waterproof case or housing would have to be used to encapsulate those digital devices in order to avoid water going into the digital devices and damaging the electronics, mechanical or optical components inside. These kinds of waterproof case can either be soft or hard. It usually has an opening allowing the user to load the digital device into the waterproof case. It usually has a locking mechanism for locking and sealing the waterproof case.

For soft waterproof cases, a user can control some of the features of the digital devices such as push buttons, rocker switches or levers from outside of the soft case by fingers. This type of soft case can also be used for devices with resistive touch screens. Some soft cases are compatible with devices having capacitive touch screens. This type of soft case can transfer electric charge to and fro between the human body and the capacitive touch screen in certain environment and conditions. In some situation, the inner surface of the soft waterproof case is in close contact with the capacitive touch screen due to, for example, insufficient air inside the case or the air inside the case is being compressed by water pressure when the waterproof case containing the digital device is immersed in water to a certain water depth.

Besides soft waterproof cases, there are hard waterproof housings for handheld digital devices. A hard waterproof housing can provide better protection to the digital devices against impact and it can go much deeper in water than soft waterproof cases because it can withstand water pressure to a certain depth without compressing the air inside the waterproof case. Due to its "hard" property, access from outside of the housing to the digital device inside the housing with a user's finger or body part without any mechanism is impossible.

Therefore, there is a need to provide a specially designed actuator mechanism for actuating a capacitive touch screen of a digital device inside a waterproof housing.

The above description of the background is provided to aid in understanding a waterproof housing and its actuator mechanism, but is not admitted to describe or constitute pertinent prior art to the waterproof housing and its actuator mechanism disclosed in the present application, or consider any cited documents as material to the patentability of the claims of the present application.

SUMMARY

According to one aspect of the present application, there is provided a waterproof housing for a digital device having a capacitive touch screen. The waterproof housing may include a housing body for holding therein the digital device, an actuator shaft extending through an opening formed on the housing body, a press button connected to an outer end of the shaft, a probe head connected to an inner end of the shaft, and a biasing member adapted to urge the probe head away from the touch screen, whereby pushing the press button against the biasing force of the biasing member moves the probe head towards and in contact with the touch screen. The press button, the shaft and the probe head may be made of a material capable of conducting electric charge.

According to one embodiment, the probe head may include a probe pad made of rubber for direct contact with the touch screen. The probe head may include a sleeve mounted on the inner end of the shaft, and the probe pad may be mounted on an enlarged free end of the sleeve.

The waterproof housing may further include an adaptor having a first end connected to the inner end of the shaft, and a second end connected to the probe head located at an off-center position relative to a center axis defined by the shaft. The adaptor may include a through hole for receiving therein

the inner end of the shaft. The through hole of the adaptor and the inner end of the shaft received therein may have non-circular cross section, whereby the adaptor is rotatable about the center axis of the shaft, and the probe head is moveable along a circular path over the touch screen thereby carrying out a "touch-swipe" or a "touch-circle" motion across the touch screen.

The waterproof housing may further include a retaining ring fastened at the inner end of the shaft for retaining the adaptor at a position abutting against an inner surface of the housing body. The press button, the shaft, the adaptor and the probe head may be made of metal.

In one embodiment, the biasing member is a coil spring coiled around the outer end of the shaft between the press button and a washer seated in a circular recess formed on an outer surface of the housing body. The waterproof housing may further include an O-ring mounted on the shaft at the opening of the housing body for sealing a gap between the shaft and the opening.

According to another aspect of the present application, there is provided an actuator mechanism for actuating a capacitive touch screen of a digital device held in a waterproof housing. The actuator mechanism may include an actuator shaft extending through an opening formed on the housing, a press button connected to an outer end of the shaft, a probe head connected to an inner end of the shaft, and a biasing member adapted to urge the probe head away from the touch screen, whereby pushing the press button against the biasing force of the biasing member moves the probe head towards and in contact with the touch screen. The press button, the shaft and the probe head may be made of a material capable of conducting electric charge.

In one embodiment, the probe head may include a probe pad made of rubber for direct contact with the touch screen. The probe head may include a sleeve mounted on the inner end of the shaft, and the probe pad can be mounted on an enlarged free end of the sleeve.

The actuator mechanism may further include an adaptor having a first end connected to the inner end of the shaft, and a second end connected to the probe head located at an off-center position relative to a center axis defined by the shaft. The adaptor may include a through hole for receiving therein the inner end of the shaft. The through hole of the adaptor and the inner end of the shaft received therein may have non-circular cross section, whereby the adaptor is rotatable about the center axis of the shaft, and the probe head is moveable along a circular path over the touch screen thereby carrying out a "touch-swipe" or a "touch-circle" motion across the touch screen.

The actuator mechanism may further include a retaining ring fastened at the inner end of the shaft for retaining the adaptor at a position abutting against an inner surface of the housing. The press button, the shaft, the adaptor and the probe head may be made of metal.

In one embodiment, the biasing member may be a coil spring coiled around the outer end of the shaft between the press button and a washer seated in a circular recess formed on an outer surface of the housing. The actuator mechanism may further include an O-ring mounted on the shaft at the opening of the housing for sealing a gap between the shaft and the opening.

Although the waterproof housing and its actuator mechanism disclosed in the present application are shown and described with respect to certain embodiments, it is obvious that equivalents and modifications will occur to others skilled in the art upon the reading and understanding of the specification. The present application includes all such equivalents and modifications, and is limited only by the scope of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Specific embodiments of the waterproof housing and its actuator mechanism disclosed in the present application will now be described by way of example with reference to the accompanying drawings wherein:

FIG. **1** is a front perspective view of a waterproof housing for holding therein a smart phone according to an embodiment of the present application;

FIG. **2** is a back perspective view (showing actuator mechanisms) of a waterproof housing for holding therein a smart phone according to an embodiment of the present application;

FIG. **3** is an illustrative diagram showing an actuator mechanism at a rest position;

FIG. **4** is an illustrative diagram showing the actuator mechanism at an actuation position when the press button is pushed;

FIG. **5** is a cross sectional view of an actuator mechanism according to a first embodiment of the present application;

FIG. **6** is an exploded view of the actuator mechanism in FIG. **5**;

FIG. **7***a* is a cross sectional view of the actuator mechanism according to a second embodiment of the present application;

FIG. **7***b* shows the downward movement of the actuator mechanism in FIG. **7***a;*

FIG. **8** is an exploded view of the actuator mechanism in FIG. **7***a;*

FIG. **9***a* is a cross sectional view of the actuator mechanism according to a third embodiment of the present application;

FIG. **9***b* shows the downward/swiping movement of the actuator mechanism in FIG. **9***a*; and

FIG. **10** is an exploded view of the actuator mechanism in FIG. **9***a.*

DETAILED DESCRIPTION

Reference will now be made in detail to a preferred embodiment of the waterproof housing and its actuator mechanism disclosed in the present application, examples of which are also provided in the following description. Exemplary embodiments of the waterproof housing and its actuator mechanism disclosed in the present application are described in detail, although it will be apparent to those skilled in the relevant art that some features that are not particularly important to an understanding of the waterproof housing and its actuator mechanism may not be shown for the sake of clarity.

Furthermore, it should be understood that the waterproof housing and its actuator mechanism disclosed in the present application are not limited to the precise embodiments described below and that various changes and modifications thereof may be effected by one skilled in the art without departing from the spirit or scope of the appended claims. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of this disclosure and appended claims.

It should be noted that throughout the specification and claims herein, when one element is said to be "coupled" or "connected" to another, this does not necessarily mean that one element is fastened, secured, or otherwise attached to another element. Instead, the term "coupled" or "connected" means that one element is either connected directly or indi-

rectly to another element, or is in mechanical or electrical communication with another element.

FIG. **1** is a front perspective view of a waterproof housing **10** for holding therein a smart phone according to an embodiment of the present application. When the smart phone is held in the waterproof housing **10**, the lens of the camera of the smart phone is positioned at the back of the transparent glass **8**. The camera can therefore take photos or videos under the water. FIG. **2** is a back perspective view of a waterproof housing **10** for holding therein a smart phone according to an embodiment of the present application. In this embodiment, actuator mechanisms **12** are provided at the back of the waterproof housing **10** and are capable of actuating the capacitive touch screen of the smart phone inside the waterproof housing **10**. The camera can therefore be controlled via the actuator mechanisms **12**.

As will be depicted in FIGS. **3-10**, actuator mechanisms **12**, **12'**, **12"** may be provided on the housing **10** at one side thereof where the capacitive touch screen is facing. The actuator mechanisms **12**, **12'**, **12"** are adapted to actuate the capacitive touch screen inside the housing **10**. Details of the actuator mechanisms **12**, **12'**, **12"** will be described later. It is understood that the waterproof housing **10** can be sized and shaped to hold therein different digital devices of different shapes and models (such as smart phone, tablet computers, digital cameras, etc.). The waterproof housing **10** may be made of a transparent material so that movement of the actuator mechanisms **12**, **12'**, **12"** can be observed and the touch screen can be viewed by a user from the outside of the housing **10**.

FIG. **3** shows the actuator mechanism **12** at a rest position. The actuator mechanism **12** may include an actuator shaft **14**, a press button **16** and a probe head **18**. At this rest position, the probe head **18** is not touching the capacitive touch screen **20**.

FIG. **4** shows the actuator mechanism **12** at an actuation position when the press button **16** is pushed downwards/inwards by a finger of a user, and the probe head **18** is touching the capacitive touch screen **20**. At this actuation position, electric charge E can be transferred between the finger of the user and the capacitive touch screen **20** through the press button **16**, the actuator shaft **14** and the probe head **18**, as shown by the arrows.

FIGS. **5** and **6** show the actuator mechanism **12** according to the first embodiment of the present application. The actuator shaft **14** of the actuator mechanism **12** may extend through an opening **22** formed on the body of the housing **10** and define a center axis X. The actuator shaft **14** can have a diameter slightly less than the diameter of the opening **22** so that the actuator shaft **14** can move smoothly inwards or outwards through the opening **22**. The actuator shaft **14** can have an outer end and an inner end. The actuator shaft **14** can be long enough to allow the outer end of the actuator shaft **14** to extend outwardly from the housing **10**, and allow the inner end of the actuator shaft **14** to extend inwardly into the housing **10**. The actuator shaft **14** may be made of metal, a metalized material or a material capable of conducting electric charge.

The press button **16** may be connected to the outer end of the actuator shaft **14**. The press button **16** can be the top part of the actuator mechanism **12**. The press button **16** may be in the shape of a mushroom or a flat head such that it is comfortable for a user to press with a finger or a hand. The press button **16** may be made of metal, a metalized material or a material capable of conducting electric charge. In addition, a thin layer of non-metal coating can be applied. This type of surface finishing can yield good contact with a user's finger or hand allowing electric charge on the touch screen **20** of the digital device to transfer to or from the finger or hand of the user.

A biasing member **40** can be used to urge the probe head **18** away from the touch screen **20**. When the press button **16** is pushed against the biasing force, it can move the probe head **18** towards and in contact with the touch screen **20**.

According to the illustrated embodiment, the biasing member **40** is a coil spring coiled around the outer end of the actuator shaft **14** between the press button **16** and a washer **42** seated in a circular recess **44** formed on an outer surface of the housing **10**. The biasing member **40** provides a biasing force to urge the press button **16** to its highest position, which is the initial position when the press button **16** is not pressed by a user. The biasing member **40** can also urge and hold the washer **42** inside the circular recess **44**. The washer **42** may be made of metal or plastic.

Although a coil spring has been shown, it is understood by one skilled in the art that any other suitable type of biasing member, such as a leaf spring, may be used.

An O-ring **50** may be mounted on the actuator shaft **14** at the opening **22** of the waterproof housing **10** for sealing the gap between the actuator shaft **14** and the opening **22**. The O-ring **50** can be disposed underneath the washer **42** and seated inside a circular recess **52**. The O-ring **50** may be made of elastic material such as rubber or synthetic rubber. The O-ring **50** may have an inner diameter slightly smaller than the diameter of the actuator shaft **14** so that the O-ring **50** can tightly fit around the actuator shaft **14**. Furthermore, the diameter of the circular recess **52** may be slightly smaller than the outer diameter of the O-ring **50** so that the O-ring **50** can be tightly fitted inside the circular recess **52**. Because of the application of the O-ring **50**, the actuator shaft **14** can move outwards and inwards while maintaining the housing **10** in a tightly sealed condition. In addition, a water-sealing compound can be applied in between the O-ring **50**, the circular recess **52** and the actuator shaft **14** to enhance the water-sealing performance while lubricating the actuator shaft **14** and smoothing its movement, and minimizing the friction created by the O-ring **50**.

According to the illustrated embodiment in FIGS. **5** and **6**, the probe head **18** may include an adaptor in the form of a sleeve **28** and a probe pad **30** for direct contact with the touch screen **20**. The sleeve **28** may be mounted on the inner end of the actuator shaft **14** and the probe pad **30** can be mounted on an enlarged free end of the sleeve **28**. The sleeve **28** may be formed with internal threads for threadedly engaging complementary external threads formed on the inner end of the actuator shaft **14**.

The probe pad **30** may be made of soft material such as rubber. Additive may be added to the rubber in order to enhance its electric charge transfer performance. Soft material is used because it can minimize possible scratch or damage on the touch screen **20**.

FIGS. **7***a*, **7***b* and **8** show the second embodiment of the actuator mechanism **12** of the waterproof housing **10**. According to this embodiment, the actuator mechanism **12'** may include an adaptor **28'**. The adaptor **28'** can be formed with a through hole **58'** through which the inner end of a modified actuator shaft **14'** can pass. The diameter of the through hole **58'** can be the same as the diameter of the inner end of the actuator shaft **14'** so that the inner end of the actuator shaft **14'** can be tightly fitted in the through hole **58'**.

The adaptor **28'** may be in the form of an arm having a first end connected to the inner end of the actuator shaft **14'** and a second end connected to a probe head **18'** disposed at an off-center position away from the center axis X of the actuator

shaft **14'**. The probe pad **30** can be mounted on the probe head **18'**. A retaining C-ring or E-ring **60**, or other type of fastener may be used to hold the adaptor **28'** at a position abutting against an inner surface of the housing **10**.

The adaptor **28'** may be made of metal, a metalized material or a material capable of conducting electric charge. The adaptor **28'** may have a comparatively larger flat surface or mushroom shape head in order to improve the electric charge transfer to or from the touch screen **20**.

At an initial state, as illustrated in FIG. **3**, the press button **16** is at its highest position when the press button **16** is released and the biasing member **40** is urging the press button **16** upwards. The biasing member **40** pushes the washer **42** downwards thereby holding the O-ring **50** inside the circular recess **52** formed on waterproof housing **10**. Since the press button **16** is at its highest position, the probe head **18** being connected to the shaft **14** is also at its highest position. Therefore, the probe head **18** is not touching the capacitive touch screen **20** of the digital device inside the waterproof housing **10**. The electric charge E on the capacitive touch screen **20** does not change.

When a user's finger or body part starts to touch the press button **16** and begins to press downwards, the user's finger or body part gets intimate with the press button **16** and the contact area with the press button **16** increases. Since the press button **16** is metal or metalized, the user's finger or body part is electric charge connected.

When the user's finger or body part continues to press downwards, the electric charge conductivity between the press button **16** and the user's finger or body part further improves. The press button **16** together with the actuator shaft **14** starts to move downwards. The biasing member **40** supporting the press button **16** is compressed. Since an O-ring **50** is installed on the actuator shaft **14** with a water-sealing compound, it can prevent water outside the waterproof housing **10**, **10** from entering into the waterproof housing **10**, **10** and damaging the digital device held therein. The probe head **18** carried by the actuator shaft **14** starts touching the touch screen **20**. When the probe pad **30** is further pressed onto the touch screen **20**, the probe pad **30** starts to deform and form a larger contact area with the touch screen **20**, as depicted in FIG. **4**, thereby enhancing the electric charge conductivity. Through the large flat or mushroom-shaped surface of the press button **16**, the actuator shaft **14** and the probe head **18**, it starts to transfer or receive electric charge to or from human body. This results in change of electric charge on the touch screen **20**. The digital device can then compute a set of coordinates on the touch screen display.

When the press button **16** is released, the biasing member **40** then pushes the press button **16** upwards. The actuator shaft **14** and the probe head **18** also move upwards thereby separating the probe head **18** from the touch screen **20** and stopping the interaction with the touch screen **20**. The operation of the actuator mechanism **12** is then completed.

In some situation when the designated location of the press button **16** does not match with the sensing location of the touch screen **20** due to design limitations, then the probe head **18** may need to be mounted at an off-center position away from the center axis X of the actuator shaft **14**. Therefore, another embodiment with modification from the previous embodiment is required.

FIGS. **7***a*, **7***b* and **8** show the actuator mechanism **12'** according to another embodiment of the present application. In this embodiment, the actuator mechanism **12** may include an adaptor in the form of an extension arm **28'**. The extension arm **28'** may be made of metal or other charge conductive material. One end of the extension arm **28'** may be attached to the modified actuator shaft **14'** by means of the E-ring **60** or other suitable fastening techniques. The E-ring **60** can be used to retain the extension arm **28'** at a position abutting an inner surface of the waterproof housing **10**. At the other end of the extension arm **28'**, a probe head **18'** with a similar design as the previous embodiment may be provided.

In order to prevent the extension arm **28'** from swinging or rotating about the actuator shaft **14** which may result in the probe head **18** probing at the wrong location on the touch screen **20**, one or more posts or guides (not shown) may be provided along the sides of the extension arm **28'**. This allows the probe head **18'** to moves only vertically up or down, as illustrated in FIG. **7***b*. The press button **16**, the actuator shaft **14'**, the extension arm **28'** and the probe head **18'** form a complete electric charge conducting path. When a user presses the press button **16**, the probe head **18'** moves downwards together with the press button **16**, the actuator shaft **14'** and the extension arm **28'**. The probe head **18'** then comes into contact with the touch screen **20**. This results in a change of electric charge on the touch screen **20**. The digital device is then able to detect the occurrence of the touch and compute a set of coordinates on the touch screen display.

In some situation when the touch screen **20** of the digital device requires "touch-swipe" or "touch-circle" motion rather than just a "touch" motion at a designated location, the probe head **18'** may need to move in a swiping or circular motion after it touches the touch screen **20**. A further embodiment with modification from the previous embodiment is required.

FIGS. **9***a*, **9***b* and **10** show the actuator mechanism **12"** according to another embodiment of the present invention. In this embodiment, the inner end of the actuator shaft **14"** is formed into a non-circular shape, such as rectangular shape. It matches to an adaptor **28"** with a through hole **58"** of the same shape. The adaptor **28"** has one end connected to the actuator shaft **14"** and another end incorporated with a probe head **18"**. Similarly, retaining ring such as an E-ring **60** or other fastening techniques may be used to retain the adaptor **28"** at a position abutting an inner surface of the waterproof housing **10**. The press button **16**, the actuator shaft **14"**, the adapter **28"** and the probe head **18"** form a complete electric charge conducting path.

When a user presses the press button **16**, the probe head **18"** moves downwards together with the press button **16**, the actuator shaft **14"** and the adaptor **28"**. The probe head **18"** moves towards and then comes into contact with the touch screen **20**. This results in a change in electric charge on the touch screen **20**. The digital device is then able to detect the occurrence of the touch and compute a set of coordinates on the touch screen display. When a user turns the press button **16** while pressing the press button **16**, the actuator shaft **14"** rotates about the center axis X of the actuator shaft **14"**. The probe head **18"** of the adaptor **28"** can move along a circular path around the actuator shaft **14"** while the probe head **18"** is touching the touch screen **20**, as depicted in FIG. **9***b*. The touch screen **20** can then detect the change in electric charge along the path and compute new sets of coordinates on the touch screen display. Therefore, the actuator mechanism **12"** of the present embodiment can perform a "touch-swipe" or a "touch-circle" motion so as to activate a function on the touch screen **20**.

While the waterproof housing and its actuator mechanism disclosed in the present application have been shown and described with particular references to a number of preferred embodiments thereof, it should be noted that various other changes or modifications may be made without departing from the scope of the appending claims.

What is claimed is:

1. A waterproof housing for a digital device having a capacitive touch screen, the waterproof housing comprising:

a housing body for holding therein the digital device;

an actuator shaft extending through an opening formed on the housing body;

a press button connected to an outer end of the shaft;

a probe head connected to an inner end of the shaft;

a biasing spring adapted to urge the probe head away from the touch screen, wherein pushing the press button against a spring force of the biasing spring moves the probe head towards and in contact with the touch screen; and

a biasing deformable dome-shaped pad mounted on the probe head facing the touch screen, and adapted to come into contact with and deform into a generally flat surface urging against the touch screen when the press button is further pushed against the spring force of the biasing spring and a biasing force of the biasing deformable dome-shaped probe pad;

wherein the press button, the shaft, the probe head and the probe pad are made of materials capable of conducting electric charge; and wherein when a contact area between the probe pad and the touch screen becomes large enough, electric charge passes through the press button, the shaft, the probe head and the probe pad to the touch screen.

2. The waterproof housing as claimed in claim 1, wherein the probe head comprises a sleeve mounted on the inner end of the shaft, and the probe pad is mounted on an enlarged free end of the sleeve.

3. The waterproof housing as claimed in claim 1, further comprising an adaptor having a first end connected to the inner end of the shaft, and a second end connected to the probe head located at an off-center position relative to a center axis defined by the shaft.

4. The waterproof housing as claimed in claim 3, wherein the adaptor comprises a through hole for receiving therein the inner end of the shaft.

5. The waterproof housing as claimed in claim 4, wherein the through hole of the adaptor and the inner end of the shaft received therein have non-circular cross section, whereby the adaptor is rotatable about the center axis of the shaft, and the probe head is moveable along a circular path over the touch screen thereby carrying out a "touch-swipe" or a "touch-circle" motion across the touch screen.

6. The waterproof housing as claimed in claim 3, further comprising a retaining ring fastened at the inner end of the shaft for retaining the adaptor at a position abutting against an inner surface of the housing body.

7. The waterproof housing as claimed in claim 3, wherein the press button, the shaft, the adaptor and the probe head are made of metal.

8. The waterproof housing as claimed in claim 1, wherein the biasing spring is a coil spring coiled around the outer end of the shaft between the press button and a washer seated in a circular recess formed on an outer surface of the housing body.

9. The waterproof housing as claimed in claim 1, further comprising an O-ring mounted on the shaft at the opening of the housing body for sealing a gap between the shaft and the opening.

10. An actuator mechanism for actuating a capacitive touch screen of a digital device held in a waterproof housing, the actuator mechanism comprising:

an actuator shaft extending through an opening formed on the housing;

a press button connected to an outer end of the shaft;

a probe head connected to an inner end of the shaft;

a biasing spring adapted to urge the probe head away from the touch screen, wherein pushing the press button against a biasing force of the biasing spring moves the probe head towards and in contact with the touch screen; and

a biasing deformable dome-shaped probe pad mounted on the probe head facing the touch screen, and adapted to come into contact with and deform into a generally flat surface urging against the touch screen when the press button is further pushed against the spring force of the biasing spring and a biasing force of the biasing deformable dome-shaped probe pad;

wherein the press button, the shaft, the probe head and the probe pad are made of materials capable of conducting electric charge; and wherein when a contact area between the probe pad and the touch screen becomes large enough, electric charge passes through the press button, the shaft, the probe head and the probe pad to the touch screen.

11. The actuator mechanism as claimed in claim 10, wherein the probe head comprises a sleeve mounted on the inner end of the shaft, and the probe pad is mounted on an enlarged free end of the sleeve.

12. The actuator mechanism as claimed in claim 10, further comprising an adaptor having a first end connected to the inner end of the shaft, and a second end connected to the probe head located at an off-center position relative to a center axis defined by the shaft.

13. The actuator mechanism as claimed in claim 12, wherein the adaptor comprises a through hole for receiving therein the inner end of the shaft.

14. The actuator mechanism as claimed in claim 13, wherein the through hole of the adaptor and the inner end of the shaft received therein have non-circular cross section, wherein the adaptor is rotatable about the center axis of the shaft, and the probe head is moveable along a circular path over the touch screen thereby carrying out a "touch-swipe" or a "touch-circle" motion across the touch screen.

15. The actuator mechanism as claimed in claim 12, further comprising a retaining ring fastened at the inner end of the shaft for retaining the adaptor at a position abutting against an inner surface of the housing.

16. The actuator mechanism as claimed in claim 12, wherein the press button, the shaft, the adaptor and the probe head are made of metal.

17. The actuator mechanism as claimed in claim 10, wherein the biasing spring is a coil spring coiled around the outer end of the shaft between the press button and a washer seated in a circular recess formed on an outer surface of the housing.

18. The actuator mechanism as claimed in claim 10, further comprising an O-ring mounted on the shaft at the opening of the housing for sealing a gap between the shaft and the opening.

19. A method for actuating a capacitive touch screen of a digital device held in a waterproof housing, the method comprising the steps of;

providing an actuator mechanism comprising an actuator shaft extending through an opening formed on the housing, a press button connected to an outer end of the shaft, a probe head connected to an inner end of the shaft, a biasing spring adapted to urge the probe head away from the touch screen, and a biasing deformable dome-shaped probe pad mounted on the probe head facing the touch

screen, wherein the press button, the shaft, the probe head and the probe pad are made of materials capable of conducting electric charge;

pushing the press button against a spring force of the biasing spring to thereby move the probe head towards the touch screen; and

further pushing the press button against the spring force of the biasing spring and a biasing force of the biasing deformable dome-shaped probe pad so that the dome-shaped probe pad comes into contact with and deforms into a generally flat surface urging against the touch screen, wherein when contact area between the probe pad and the touch screen becomes large enough, electric charge passes through the press button, the shaft the probe head and the probe pad to the touch screen.

20. The method as claimed in claim **19**, further comprising the step of rotating the press button to thereby carry out a "touch-swipe" or a "touch-circle" motion across the touch screen.

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